SECTION VII

SYSTEMS OPERATION

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ENGINE.

ENGINE CONTROL SYSTEM.

The power available from the engine is proportional to the gas generator speed (N_g) and power turbine inlet temperature (T_5) relationship. The engine must be operated within the N_g and T_5 limits. The engine fuel control accomplished this by maintaining certain scheduled acceleration, deceleration, and steady state limits. Acceleration, due to increased power requirements or throttle movement, is controlled by a maximum fuel flow schedule limit, or by the topping governor. Deceleration, due to decreased power requirements or throttle movement, is controlled by a minimum fuel flow schedule. Selected steady state conditions are maintained at optimum efficiency by a leadlag servo system which dampens the effect of power transients, and the control governor which maintains power turbine speed within the specified 8.5% droop limit at maximum throttle position.

FUEL CONTROL SCHEDULING.

The fuel control does not monitor power turbine inlet temperature (T_5) directly. It monitors compressor discharge pressure and adjusts fuel flow to maintain engine temperatures within safe and predetermined scheduled limits. The amount or ratio of fuel to be burned, in proportion to the amount of compressor air available for both combustion and cooling, directly determines the temperature of the combustion gases at any point in a turboshaft engine. This ratio is known as W_f (weight flow of fuel) to compressor discharge pressure (P_3), and is used within the control to determine the required fuel flow schedules. Maintenance of a continuous flame within the gas generator combustion system depends on a proper mixture of fuel and air. As performance factors change, the values of both will change. The proportion between the two must be maintained or scheduled within limits or the flame will be lost (blowout or flameout). During deceleration, if fuel flow (which is decreasing) drops below a given amount, a lean blowout due to an insufficient amount of fuel for the air being used may occur. During acceleration, if fuel flow (which is increasing) rises above a given amount, a rich blowout and/or overtemperature due to an excessive amount of fuel for the air being used may be encountered.

TOPPING GOVERNOR.

The fuel control incorporates a topping governor which operates as a safety device, preventing overtemperature and overspeed of the gas generator. There exists a relationship between the operating temperature (T_5) and the gas generator speed (N_g). This temperature/speed relationship is a function of ambient temperature (T_2). The topping governor limits the maximum attainable gas generator speed for various ambient temperatures, and in doing so limits the maximum operating temperature (T_5). The topping governor is therefore a speed control exclusively, indirectly controlling T_5. For operation at maximum power, the gas generator operator operates near or at the highest possible T_5, except when low ambient temperatures (T_2) are encountered; then the maximum gas generator speed limit is reached first.

BOTTOMING.

The engine is considered at bottoming during deceleration whenever a minimum fuel flow (W_f) to compressor discharge pressure (P_3) ratio is attained. The bottoming schedule determines gas generator idle speed and the minimum W_f/P_3 ratio to sustain normal combustion.

DROOP.

Actual power turbine speed may vary from 5.5 to 8.5 percent from minimum to maximum load at a given throttle position in the N_f governing range. This droop characteristic is a design feature incorporated to ensure N_f stability and to provide better multi-engine load sharing. The engine control parameters (N_g, W_f/P_3, and T_2) which maintain power turbine speed (N_f) within the desired operational tolerance for any given condition, are commonly referred to as droop lines or droop schedules.

GOVERNING RANGE.

In the governing range the engine drives the helicopter rotor at the speed and power selected by the pilot. The fuel control governing range is 89% N_f or above. However, the beeper trim system range is approximately 91% to 108%. The engine control system maintains this selected speed by varying gas generator speed to meet the different power requirements produced by a change in the helicopter blade pitch angles, forward speeds, and atmospheric conditions. As blade pitch angle is increased, the engine fuel control increases gas generator speed until the maximum gas generator speed is reached. If the blade pitch angle is increased after the maximum gas generator speed is reached, a reduction in main rotor speed will occur.

TEMPERATURE LIMITS.

The amount of heat which engine components (particularly turbine buckets and turbine nozzles) can withstand without structural damage limits the amount of heat energy which should be released by burning fuel. Temperature is controlled by limiting the maximum fuel flow for the prevailing gas generator speed and inlet conditions.

COMPRESSOR STALLS.

Stall designates reversals of flow within the compressor. The severity of stall depends upon the number of reversals which take place per second. Low speed compressor stall is indicated by a moderate to fast rise in exhaust gas temperature. Severe compressor stall is marked by violent mechanical vibrations and increased engine noise level. Each compressor has a maximum pressure ratio for every speed at which it operates. The maximum pressure ratio sets a limit on the compressor discharge which can result from rotating the compressor at a particular speed. As long as the pressure at the compressor discharge equals, or is below this limit, the compressor will deliver air smoothly. However, if this limit is exceeded, flow will be reduced and there will be some reverse flow through the compressor. If it were not for the engine fuel control system, stall could occur during an attempt to accelerate the engine. A sudden and excessive increase in fuel flow might generate a volume of gas which would create an excessive back-pressure at the compressor discharge, and compressor stall would result. Because each compressor speed has its own maximum compressor ratio, each must have its own stall point. Stall is avoided automatically by the fuel control which limits fuel flow during engine acceleration.

COLD HANGUP.

During a normal start on the automatic system of the fuel control, certain fuel flow scheduling malfunctions, although not affecting engine lite-off capabilities, may cause the engine gas generator speed (N_g) to fail to accelerate to normal idle speed. N_g will remain at approximately 35% with T_5 low. In this case, the emergency fuel control lever can be utilized after lite-off, to bypass the automatic features of the control and provide manual scheduling of fuel by the pilot to assist the engine acceleration to the normal idle speed range.

MAXIMUM POWER AVAILABLE AND TOPPING.

Maximum power available checks may be accomplished while in a hover, while in forward flight, or while on the ground; however, checks made while in a hover are more accurate. The foreign object deflector, when installed, reduces power available during forward flight; and, when not installed, ram air increases power available. Checks made with the helicopter on the ground are least desirable but are sometimes necessary because of dust, loose snow, helicopter too heavy to hover, etc. When the power available checks and topping adjustments are made with the helicopter on the ground or in low hover below 10 feet, T_5 limits may be reached early because of recirculation of exhaust gases into engine intake. Therefore, it is recommended that engine topping be rechecked after takeoff. Before making this check, compute the maximum power available for existing temperature and altitude. Compare the torque computed with that torque attained. If engine deterioration is suspected, proceed with N_g/T_5 relationship check in this section. During all the following procedures, be constantly aware of the engine and transmission limitations; namely, 721°C T_5 and 102.7% N_g, and 103% torque (123% single engine).

CAUTION

While making this check, it is permissible to operate the engine above 102.7% N_g and above 721°C T_5 for up to 28 seconds. However, under no circumstances should the engine be operated above 106% N_g or 735°C T_5 for any time period.

NOTE

Maximum power available checks performed in forward flight are not as accurate as those performed in a hover. However, when required to perform a maximum power available check during forward flight, the following approximate corrections should be applied to the power computed value obtained from chart (figure A-3). Do not use the correction from figure A-7 with the following table.

	CORRECTION WITH FOD SHIELD ON	CORRECTION WITH FOD SHIELD OFF
60 KIAS	-1	+1
80 KIAS	-2	+1
100 KIAS	-3	+2
120 KIAS	-3	+3
140 KIAS	-4	+4

Example given: OAT = +20°C, pressure altitude = 6,000 feet. N_r-103, 80 KIAS. FOD shield on. Find: maximum power available.

Enter chart A-3 at plus 20°C on the "with wind or forward flight" line. Go horizontally to 6,000 feet PA and then down vertically to 103 N_r. The answer (uncorrected for FOD Shield) is 88% Q. Subtract 2% Q to get 86% Q. This is what the engine should be producing at 80 KIAS forward flight. If it does not proceed with the maximum power, check in the next paragraph if necessary to complete the mission.

Maximum Power Available Check.

The following procedure describes a maximum power available check on the No. 1 engine with the helicopter either in a hover or forward flight. Checks made with the helicopter on the ground should be made on one engine, using collective to obtain desired engine readings. Maximum power available on No. 2 engine should be checked in the same manner. If the engine is not properly topped during the maximum power available check, proceed with topping adjustment.

1. Record OAT.
2. Push both throttles to maximum.
3. Using the engine beeper trim button advance No. 1 throttle to maximum N_f.
4. If limits have not yet been reached, slowly retard the throttle on No. 2 engine, observing the corresponding rise in N_g, T_5, and torque of No. 1 engine.
5. Continue retarding No. 2 throttle until N_g and T_5 of the No. 1 engine no longer increase and N_f droops at least two percent. Note the N_g and T_5 readings on No. 1 engine. This is the topping reading.

NOTE

When OAT is below 10°C, the anti-icing system should be turned on when the topping check is made. At these low temperatures, with anti-ice operating, an increase in T_5 will result at any given N_g speed since additional airflow is being extracted from the compressor. If an engine is at topping, or is using maximum power with anti-icing off, and it is subsequently turned on, an overtemperature condition can result if the engine is already at or near the T_5 limits. If the engine is topped with the anti-icing on, subsequent deactivation of the anti-icing system will not result in T_5 overtemperature or N_g overspeed unless the OAT has increased sufficiently to affect the temperature limits. When engines are topped with the anti-icing system on, maximum power (torque) available will be some four percent less than topping with the anti-icing system off.

5. No adjustment to topping is required if either of the following conditions is met:

   a. For recorded OAT, N_g is within +0.0% to -0.5% of limit shown in figure A-39 and T_5 is less than 721°C.

   b. T_5 is 716°C to 721°C and N_g does not exceed the maximum operational limit shown in figure A-39 for recorded OAT.

CAUTION

A sudden increase in torque of the adjusting screw may indicate that the topping adjustment screw has bottomed. If this happens, do not attempt further adjustment. Continued rotation could cause failure of internal components of the fuel control.

SEE 1S-165 AMENDED

Higher Than Predicted Engine Performance

If higher than predicted engine performance values occur, comply with torque system check, this section. If maintenance actions validate the torque indicating system as being accurate; and high torque is confirmed by a corresponding fuel flow, the torque indications are considered reliable. For approach planning factors, however, maximum

SEE 1S-165 AMENDED

power available values should reflect the charted values specified in the flight manual performance data.

Topping Adjustments.

1. If T_5 is less than 716°C and N_g is more than -0.5% below maximum speed limit specified in figure A-39 for recorded OAT, proceed as follows:

   a. Reduce power on engine being adjusted until N_g is at least 2% below topping.

   b. Direct crewman to rotate topping adjustment clockwise, being careful not to exceed T_5 limit. One full turn (36 clicks) increases topping approximately 2-1/4% N_g (16 clicks, approximately 1% N_g; 1 click equals approximately 1°T_5).

   c. Repeat steps 1 through 5 of Maximum Power Available Check until one of the conditions in step 5 is met.

   d. When ambient temperatures are below 25°C and no increase in N_g is noted after topping adjustment has been increased, reset adjustment to original position. Engine is operating on its maximum fuel flow limit. In this case, it is necessary to fly at higher altitudes, as indicated in the following chart, where high gas generator speeds are obtained at lower fuel flows.

Ground Ambient Temperature	Altitude Required
Above 25°C	Sea level
-24°C to 25°C	2500 feet
-41°C to -24°C	5000 feet
Below -41°C	7500 feet

2. If T_5 exceeds 721° or N_g exceeds the speed limit specified in figure A-39 for recorded OAT, proceed as follows:

   a. Reduce power on engine being adjusted until N_g is at least 2% below topping.

   b. Rotate topping adjustment counterclockwise. One full turn (36 clicks) decreases topping approximately 2-1/4% N_g (16 clicks, approximately 1% N_g; 1 click equals 1°T_5).

   c. Repeat steps 1 through 5 of Maximum Power Available Check until one of the conditions in step 5 is met.

TORQUE SYSTEM CHECK.

Maximum power available computations reflect military specification engine performance. If indicated power available exceeds computed power available, the following will help the flight crew determine if the engine exceeds specification performance or if torque system error exists. During maximum power available check, indicated torque must be within plus or minus 5 percent of computed. If maximum power available differs more than plus or minus 5 percent of computed, evaluate the governing parameters (actual OAT, pressure altitude) to determine if the error was made in TOLD computation. If TOLD is correct, record the discrepancy in the AIRCRAFT FORMS including all pertinent data i.e., N_g, T_5, W_f, Q, OAT, and PA. Return the aircraft to maintenance. If a main gear box torque cell indicating error between 6 percent and 10 percent above computed is confirmed in the 104 percent - 123 percent torque range, the exact amount will be entered in the Aircraft Forms. The aircraft may be operated with this known condition provided the aircrew is able to confirm maximum power available with fuel flow, (Ref A-6). Aircraft with a confirmed main gearbox torque cell indicating error more than 10 percent above computed will not be flown.

ENGINE FUEL CONTROL SYSTEM OPERATION.

The engine fuel control system must schedule fuel flow and variable vane positioning during three general operating conditions. These general operating conditions are: starting, idle, and governing range. The regimes of these conditions are related to the various engine speed control lever settings.

ENGINE STARTING.

During start, as the throttle is advanced to the GRD IDLE position, the stopcock opens and allows fuel to pass through the flow divider and to enter the number one (low pressure) manifold to the nozzles where it is mixed with compressor-discharge air. As the fuel-air mixture leaves the nozzles, it is ignited by the two igniter plugs in the combustion chamber and enters a sustained combustion process. The fuel temperature sensing portion of the flow divider operates in conjunction with an auxiliary metering valve in the fuel control. The auxiliary metering valve is arranged in tandem with the main metering valve in a manner that allows its orifice area to decrease as the orifice area of the main metering valve increases. The lower portion of the flow divider housing contains a bellows that senses fuel temperature to vary the area opening of an attached needle valve. The temperature compensated needle valve and the fuel control auxiliary metering valve are arranged in series with each other and in parallel with the main metering valve. Fuel flow past the auxiliary metering valve is routed to the flow divider needle valve where it is biased by fuel temperature and then ported back to the fuel control to be added to the main flow. As the engine accelerates and fuel flow increases, the auxiliary metering valve will move toward the closed position and will be fully closed at 250 lb/hr flow. At this point, the temperature-compensating system is eliminated and total fuel will be metered by the main system.

Normal Start.

A normal start is one in which the engine accelerates from starter initiation, through lite-off, to idle speed in a 40 second time period (standard day conditions). This time period includes: 20 seconds from time starter is engaged to lite-off, (10 seconds maximum for starter to accelerate engine from 0 to 19% N_g and 7 to 10 seconds to lite-off), and 20 seconds as the engine accelerates to idle speed. Engine acceleration from lite-off to ground idle is a function of ambient air temperature and can vary from a 20 second minimum at 15°C to a maximum of 30 seconds at 55°C, or 45 seconds at -55°C. The normal engine starting procedure requires starting the APU first so that the accessory section of the main gear box is activated.

Starting and Rotor Engagement Procedures With APU Inoperative.

This procedure is limited to ambient temperatures above -6.7°C. The main transmission chip detector should be monitored, during flight, following an engine start and rotor engagement with APU inoperative.

NOTE

This procedure is allowed to permit use of the helicopter, with the APU inoperative, when overriding operational requirements dictate. However, accelerated wear to the main transmission input sleeve bearings can be expected when using this procedure.

Engine Starting With External Power.

Should the APU be inoperative, the engines may be started with either ac or dc external power. Accomplish ENGINE STARTING AND ROTOR ENGAGEMENT procedures outlined in Section II for one of the engines, with rotor brake off, and refer to Rotor Engagement With APU Inoperative in this section.

Starting With Battery.

Should the APU be inoperative, and neither ac nor dc external power is available, it may be possible to start the engines with battery power only. All dc operated equipment not essential for engine start must be rendered inoperative, either by turning off switches or pulling circuit breakers, to permit maximum utilization of available battery power to attempt to obtain 19% N_g for the engine start. One engine should be started from the battery, and the start should be made with the rotor brake off. Prior to attempting start, refer to Emergency Battery Start in Section III and Rotor Engagement With APU Inoperative in this section. A normal engine start is possible if battery power enables N_g to reach 19%. If N_g does not reach 19% after starter engagement, use emergency battery start procedures found in Section III if the risk of aircraft damage is justified by the urgency of the situation.

CAUTION

When starting with less than 19% N_g is attempted, a successful start is unlikely and engine overtemperatures should be expected.

NOTE

If initial attempt is aborted, make second attempt on other engine.

Paralleling Batteries.

In the event that the battery voltage is so low that a battery start cannot be accomplished, an additional source of battery power may be connected in parallel with the installed battery, either at the battery or through the dc external power receptacle.

NOTE

When paralleling batteries through the dc external power receptacle, both the battery and external power switches must be on and the battery compartment door must be opened.

Rotor Engagement With APU Inoperative.

Should the APU be inoperative, and one engine can be started by utilizing external power, or battery power, it is imperative that extreme caution be exercised when engaging the rotor head. The rotor brake should be off as the one engine is started. After engine lite-off, and as N_g increases, the rotor head will begin to rotate. At approximately 8% N_r, the transmission oil pressure should be above minimums required, servo pressures should be sufficient to operate the flight controls, and a successful rotor engagement can be completed. As the rotor acceleration continues, utilize minimum torque necessary for a smooth rotor engagement. The throttle should not be advanced forward of the ground idle position until the transmission oil pressure and servo pressures are normal. As the rotor builds up speed, the transmission oil pump supplies the required lubrication. The cyclic stick and collective pitch lever must be held firmly, since a slight kickback may feed back into the controls as servo pressure builds up. After the rotor is engaged, disconnect the external power (if connected) and start the other engine. After the rotors are engaged, complete items under BEFORE STARTING ENGINES except APU start, flight control servo check, cyclic stick trim check.

CAUTION

- The throttle should not be advanced forward of the ground idle position until the transmission oil pressure and one of the servo system pressures are normal. This procedure is necessary to preclude damage to the main transmission input sleeve bearing as a result of initial lack of lubrication and to assure positive control of the rotor head system during rotor engagement.
- When ambient temperatures are -6.7°C or colder, refer to Engine Start and Rotor Engagement Procedures With APU Inoperative in Section IX.

NOTE

When an external power start has been accomplished, the flight control servo check cannot be performed as during normal procedures. If dc external power or battery was utilized, ac equipment will not be available until after rotor engagement.

Engine Starter Drop Out.

Starter operation and drop out may be determined by noting the magnetic compass heading during engine start, or by noting the loadmeters, which drop to zero when the starter is engaged and resume their normal readings when the starter drops out. When the starter is energized, the compass will swing violently to a new heading. At approximately 45 to 53% N_g, the compass should swing back to its original heading signifying the starter has dropped out. The starter bleed valve will drop out when the starter drops out.

IDLING ENGINES.

Idle to Transition Range. A small advance of the throttle will cause the engine to accelerate to the transition range. As the throttle is advanced, T_5 will advance fairly rapidly as the fuel flow/compressor-discharge pressure (W_f/P_3) ratio increases until it is limited by the fuel control. At this point, the feedback function of the fuel control will decrease the fuel flow/compressor-discharge pressure (W_f/P_3) ratio, lowering T_5, until a new steady state operation is attained. During this time, N_g should show a steady increase.

NOTE

Prolonged operation of the engine in the transition range (between idling and minimum governing range) is not recommended.

Idle to Operating (N_f Governing) Range.

As the throttle is advanced from the GRD IDLE position into the normal operating range, T_5 and N_g will advance rapidly as the fuel flow/compressor-discharge pressure ratio increases until it reaches the maximum acceleration schedule. Fuel flow will continue to increase in proportion to N_g according to the rate of speed lever advancement. At this point, the fuel flow/compressor-discharge pressure ratio and T_5 will decrease along the topping schedule as N_g increases to the new steady-state condition.

Increasing Engine Load.

Increasing engine load causes the gas generator to accelerate. During acceleration, maximum fuel flow is delivered to the engine, with the rate of increase limited by the 3D cam contours to avoid compressor stall, rich or lean blowout, or turbine over-temperature. When the gas generator speed required to match output power to the new load is reached, fuel flow decreases to level necessary to maintain the new steady-state speed.

Decreasing Engine Load.

Decreasing engine load causes the gas generator to decelerate. During deceleration, the engine fuel control supplies the minimum fuel flow which will maintain combustion until the gas generator approaches the speed which will match output power to the new load. The engine fuel control then supplies the fuel flow necessary to maintain this speed.

Retarding Throttle.

Retarding the throttle slightly, under normal or military load conditions, so that N_g does not drop below 91% N_g, will yield a deceleration not affected by feedback. The fuel flow/compressor-discharge (W_f/P_3) ratio decreases to the limit set by the new throttle position and remains constant as the engine decelerates to the new steady-state condition.

Deceleration To Idle.

Retarding the throttle from the normal operating range to GRD IDLE decreases fuel flow until the minimum fuel flow/compressor-discharge pressure ratio stop is reached. The gas generator slows down on a minimum fuel flow/compressor-discharge pressure ratio schedule and the negative feedback function of the engine fuel controls starts increasing the fuel flow/compressor-discharge pressure ratio until the bottoming schedule is reached. The gas generator then decelerates with an increasing fuel flow/compressor-discharge pressure ratio determined by the bottoming schedule until idle speed is attained.

SHUTDOWN.

The engine can be immediately shut down from any operating condition in an emergency. When the throttle is moved to the SHUTOFF position, the stopcock shuts off all fuel to engine. However, it is advisable to operate the engine for a minimum of one minute at low power to allow the engine parts in the turbine (hot) section to cool down.

CAUTION

> Indiscriminate use of emergency shutdown procedure from high performance conditions will increase the possibility of engine seizure and decrease the useful life of the engine.

ENGINE COMPRESSOR DETERIORATION.

In addition to salt water spray ingestion (refer to Section II, SALT WATER OPERATION), operational experience has shown that when helicopters operate in severe environments engines will experience a reduction in compressor efficiency and subsequent decrease in stall margin due to one or more of the following:

1. Compressor contamination and/or fouling due to inlet ingestion and buildup of carbon, dirt and oil based deposits on compressor blades/vanes, and exhaust gas reingestion.
2. Compressor blade/vane roughness and leading edge curl (erosion) due to sand/dust ingestion.
3. Compressor foreign object damage (FOD).

ENGINE COMPRESSOR STALL MARGIN CHECK.

The purpose of this check is to monitor stall margin to assure transient, stall-free operation. Monitoring the available stall margin provides a means of problem detection before inflight discrepancies occur. It is necessary to periodically accomplish stall margin check and perform required corrective maintenance when stall margin has decreased below acceptable limits. The stall margin is measured by requiring the compressor to operate with the variable vanes blocked in the open position as N_g is reduced (instructions for accomplishing stall margin check are in T.O. 1H-3(C)E-2-2).

N_g/T_5 RELATIONSHIP CHECK.

The N_g/T_5 relationship check, for comparison to the N_g/T_5 BASELINE, will identify engine compressor deterioration and thermocouple/aircraft instrument errors.

The N_g/T_5 BASELINE will be established on (1) initial engine installation or (2) following an acceptable Stall Margin Check on those engines that have accumulated time and the N_g/T_5 BASELINE was not established at initial installation. Procedures for establishing the N_g/T_5 BASELINE are contained in T.O. 1H-3(C)C-6CF-1. Also, the N_g/T_5 BASELINE will be maintained on the aircraft and filed with the AFTO 781 until the engine is replaced. When the engine is replaced, the N_g/T_5

BASELINE on the replaced engine will be destroyed and the N_g/T_5 BASELINE on the replacement engine retained with the aircraft (refer to EXAMPLE Figure 7-4 for information/guidance).

The N_g/T_5 relationship check (for comparison to the BASELINE) will be accomplished as follows:

NOTE

There will be instances when the N_g/T_5 check will not be correct on T58-GE-5 engines at OAT above 40°C. Therefore, this check should be made at a lower OAT.

a. Perform the N_g/T_5 relationship check in any flight condition. Shut off anti-icing/compressor bleed. Also, if check is made in a hover, perform check at 40 feet (or higher) wheel height and head aircraft into the wind. This will prevent reingestation of exhaust gases.

b. Observe aircraft OAT. Select an OAT on the N_g/T_5 BASELINE chart closest to the aircraft OAT observed and establish the required N_g.

c. Stabilize N_g and record indicated T_5. Move horizontally to the right from the selected OAT to the "X" T_5 column (BASELINE).

d. If the indicated T_5 is more than 20°C below the "X" column value, make a Form 781 entry as this indicates possible instrumentation error.

e. If indicated T_5 is more than 35°C above the "X" column value, make a Form 781 entry as this indicates possible engine deterioration. Aircraft will not be flown until corrective action is taken.

ALTERNATE FUELS.

Flow divider density settings significantly affect engine starting characteristics if an improper density setting is utilized. However, once a successful start has been achieved, engine operation on any of the approved alternate fuels will be normal regardless of fuel control/flow divider density setting. To preclude starting problems, alternate fuels (see figure 7-1) should be chosen, if possible, which have the same density setting as the fuel remaining in the tank. When fuels requiring different density settings are mixed, or when the fuel density is unknown, (see figure 7-2) the flow divider/fuel control should be set at JP-4. In this situation the engine may experience a cold hangup, which can be corrected by USE OF EMERGENCY FUEL CONTROL LEVER TO ASSIST STARTING procedures in Section III. The density setting should be changed to JP-5 once it is assured that the fuel control/flow divider contains an alternate fuel requiring a JP-5 density setting and the change entered in the Form 781. The following order of preference should be utilized when selecting an alternate fuel for cold weather operation (-10°F OAT and below).

General Grade	Starting Temperature Limit (Approximate)
JP-4	-65°F
Commercial Jet-B	-65°F
JP-5	-55°F
Commercial Jet A-1	-25°F
Commercial Jet A	-20°F
JP-8	-20°F

FUEL SYSTEM.

(Refer to figure 7-3.)

FUEL SYSTEM MANAGEMENT.

Forward and Aft Main Tanks.

Only that fuel contained in the forward and aft main tanks can be supplied directly to the engines. Fuel contained in the internal or external auxiliary tanks must be transferred into the forward or aft main tanks before it can be supplied to the engines. During normal operations, the forward tank supplies the No. 1 engine and the aft tank supplies the No. 2 engine. Each main tank contains two boost pumps which improve the engine operating envelope by providing fuel under pressure. Continuous use of one boost pump per tank is recommended to prevent inadvertent operation without boost pumps when their use is required (Refer to EQUIPMENT LIMITATIONS, SectionV).

	MILITARY SPECIFICATION	FUEL GRADE	NATO SYMBOL	FREEZE POINT °C	COMMERCIAL DESIGNATION
RECOMMENDED FUELS					
	MIL-T-5624	JP-4	⚠2 F-40	–58	
ALTERNATE FUELS					
HIGH FLASH POINT KEROSENE	MIL-T-5624	JP-5	⚠2 F-44	–46	
	MIL-T-83133	JP-8	⚠2 F-34	–50	JET A-1
KEROSENE			F-34	–40	JET A
			F-35	–47	JET A-1
EMERGENCY FUELS					
LEADED AVIATION GASOLINE (NOT CONTAINING TCP)	MIL-G-5572	80/87	F-12	–60	AvGas 80/87
	MIL-G-5572	100/130	F-18	–60	AvGas 100/130
	MIL-G-5572	115/145	F-22	–60	AvGas 115/145

WARNING

WHEN USING FUELS WITHOUT ICING INHIBITOR, AVOID FLYING AT ALTITUDES WHERE INDICATED OAT IS BELOW 0°C TO PRECLUDE FUEL SYSTEM ICING.

NOTE

1. FUELS LISTED FROM TOP TO BOTTOM IN ORDER OF PREFERENCE.

⚠2 CONTAINS FUEL SYSTEM ICING INHIBITOR (FS11).

3. REFER TO T.O. 42B1-1-14 FOR ADDITIONAL FUEL USAGE DATA.

4. REFER TO NATO INTERCHANGEABILITY TABLES T.O. 42B1-1-15 FOR NATO NATIONAL SPECIFICATIONS.

Figure 7-1. Fuel Availability Chart

FUEL, FUEL CONTROL AND DIVIDER SETTINGS VS TYPE START TO EXPECT (INITIAL STARTS ONLY)

FUEL	FUEL CONTROL SETTING	FLOW DIVIDER SETTING	TYPE OF START TO EXPECT
JP-4	4	4	NORMAL
JP-4	4	5	MOST PROBABLE HOT
JP-4	5	4	COLD HANGUP TENDENCIES
JP-4	5	5	MOST PROBABLE HOT
JP-5	5	5	NORMAL
JP-5	4	5	HOT TENDENCIES
JP-5	5	4	MOST PROBABLE HANGUP
JP-5	4	4	MOST PROBABLE HANGUP
JP-8	5	5	NORMAL

Figure 7-2. Fuel, Fuel Control and Divider Settings vs Type Start

CAUTION

- If one fuel low-level caution light comes on, turn on all available boost pumps and open the crossfeed. If both fuel low-level caution lights come on, turn on all available boost pumps, open the cross-feed, and avoid noseup attitudes greater than six degrees.
- The boost pumps in an empty tank should be shut off to conserve the life of the boost pumps and to prevent the possibility of fire. If the boost pumps are inadvertently left on, thermal limit switches in the pumps will automatically shut the pumps off if the temperature of the pump rises to 204°C, due to the lack of lubrication. This temperature, however, is considerably lower than the spontaneous flash point of the fuel and/or vapors.

Internal Auxiliary Fuel Tanks.

The internal auxiliary fuel tank system, either single or dual tanks, may be installed to increase the range and endurance of all CH-3E helicopters prior to 16 . The single tank installation allows gravity transfer into either or both of the main tanks. The dual tank installation (two single tank systems) allows gravity transfer from the forward or aft auxiliary tank to its respective main tanks, and provides double the fuel capacity. Manual fuel shutoff valves are provided to control fuel transfer into the main tanks. The fuel transfer lines are equipped with a float valve which prevents overfilling of the main tanks. Each tank is also equipped with a fuel jettison line and dump valve.

External Auxiliary Fuel Tanks.

On CH-3E 16 and all HH-3E helicopters, external auxiliary fuel tanks may be installed to increase the range and endurance. Fuel may be simultaneously transferred from both external tanks to

OPERATION OF FUEL SYSTEM

CONDITION	CROSSFEED SWITCH	FUEL SHUTOFF VALVES	BOOST PUMP SWITCHES
		BOTH ENGINES OPERATING	
Normal Operation - Fwd tank to left engine and aft tank to right engine	CLOSED	Both - OPEN	4 pumps - ON or 1 pump - ON for each tank
Both tanks to both engines	OPEN	Both - OPEN	*4 pumps - ON or 1 pump - ON for each tank
Either tank to both engines	OPEN	Both - OPEN	*Tank in use - BOTH - ON Tank not in use - 1 pump - ON
		ONE ENGINE OPERATING	
Fwd tank to left engine or aft tank to right engine	CLOSED	Good engine - OPEN Failed engine - CLOSED	Tank in use - BOTH - ON Tank not in use - BOTH - OFF
Both tanks to either engine	OPEN	Good engine - OPEN Failed engine - CLOSED	*4 pumps - ON or 1 pump - ON for each tank
Either tank to opposite engine	OPEN	Good engine— OPEN Failed engine - CLOSED	*Tank in use - BOTH - ON Tank not in use - 1 pump - ON

*When using fuel from both tanks, it is possible that fuel will actually be supplied from one tank only. This can occur if the difference in the normal operating pressure of the boost pumps is sufficient to close the check valve downstream of the weaker pumps. When using fuel from both tanks, check the fuel quantity gages periodically. If the fuel is being consumed at an unequal rate from the tanks, it may be more satisfactory to operate from one tank at a time in order to equalize the fuel quantity in each tank. This is accomplished by turning on two boost pumps in the tank containing the greater quantity of fuel and operating only one boost pump in the other tank. If one boost pump is inoperative in the tank containing the greater amount of fuel, equalization is accomplished by shutting off the boost pumps in the tank that is not to be used.

Figure 7-3. Operation of Fuel System Table

T58GE5 Ng/T5 RELATIONSHIP CHECK

Engine S/N ____________________ A/C S/N ____________________

Date: ____________________

OAT (°C)	NG %	POWER TURBINE INLET TEMPERATURE (C^oT_5)											
								X					
-40	86.5	422	426	430	434	438	443	447	451	455	459	463	467
-35	87.5	438	442	446	451	455	459	463	467	471	475	479	484
-30	88.5	454	458	462	467	471	475	479	484	488	492	496	500
-25	89.0	465	469	474	478	482	487	491	495	499	504	508	512
-20	90.0	481	485	490	494	498	503	507	512	516	520	524	529
-15	91.0	497	501	506	510	514	519	523	528	532	537	542	546
-10	92.0	514	518	523	527	531	536	541	546	550	555	560	564
-5	92.5	524	529	534	538	543	548	552	557	561	566	571	576
0	93.5	540	545	550	555	559	564	569	574	578	583	588	593
5	94.5	557	562	567	572	576	581	586	591	596	601	605	610
10	95.5	573	578	583	588	593	598	603	608	613	617	622	627
15	96.0	585	590	595	600	605	610	615	620	625	630	635	640
20	97.0	601	605	611	616	621	626	631	636	641	645	651	657
25	97.5	614	619	624	630	635	640	645	650	655	661	666	670
30	98.5	630	635	640	645	650	656	661	666	671	677	682	687
35	99.5	646	651	657	662	667	673	678	684	689	694	699	705
40	100.0	659	664	670	675	680	686	691	697	702	708	713	718

Figure 7-4. EXAMPLE: Ng/T5 Relationship Check Chart (T58-GE-5)

both main tanks by pressurizing the external tanks with engine compressor bleed air. Placing the pressurization switch in the PRESS position will open the auxiliary tank fuel valve and the bleed air shut-off valve for the respective external tank. Float valves in the main tanks operate at approximately 1900 to 2200 pounds, allowing fuel transfer at a rate greater than dual engine consumption. Fuel may be transferred into the main tanks as and when desired during flight. To preclude possible fuel discharge during fuel transfer from external tanks, leave the main tank selector (FWD and AFT) switches in the SELECT position at all times unless it is not desired to service a particular tank during a fuel transfer or air refueling operation. To control fuel transfer, place either or both of the auxiliary fuel tank pressure switches, LTK and RTK, in the PRESS or OFF position.

CAUTION

Improper fuel transfer procedures may cause fuel to discharge from the main tank filler cap (relief) valves.

NOTE

Flow light may flicker during probe retraction and fuel transfer.

When the auxiliary fuel tanks are empty, or fuel transfer is completed, turn the pressurization switches to OFF and resume normal fuel management. Empty auxiliary tanks will be noted when the fuel indicating system shows a steady decrease in the main tank fuel levels below approximately 1700 pounds.

During ground pressure or air refueling operations, all main and auxiliary fuel tanks can be simultaneously refueled. Individual selector switch selection will also permit any one or a combination of tanks to be refueled.

Fuel Crossfeed Procedures.

The fuel crossfeed valve provides a flexible operating system. When operating on crossfeed and one tank runs dry, both engines will continue to operate providing a boost pump is ON in the tank containing fuel.

WARNING

Both engines will flame out when operating on crossfeed if one tank runs dry and the boost pumps are off in the tank containing fuel.

During single engine operation, fuel may be transferred to either engine from either or both tanks at the same time.

EXAMPLE (T58-GE-5 Engine, Figure 7-4):

1. During FCF the "X" column value (BASELINE) was established, i.e. OAT 15°C, Ng stabilized at 96%, indicated T_5 was 615°C.

2. During this check the following were observed:

   OAT = 29°C
   Ng = Stabilized at 98.5%
   T_5 = 670°C Indicated

3. Move horizontally to the right from 30°C OAT (closest to observed aircraft OAT of 29°C) until the "X" T_5 column is encountered (661°C). Allowable T_5 for this engine at this OAT is 641°C to 696°C (661° - 20°C to +35°C).

4. Engine is acceptable since observed T_5 (670°C) is within the limits of 20°C below to 35°C above the "X" column value (661°C).

SECTION VIII

CREW DUTIES

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CREW DUTIES AND RESPONSIBILITIES.

Each flight crewmember is delegated duties and responsibilities other than the primary duties outlined in NORMAL PROCEDURES, Section II. These additional duties and responsibilities are prescribed in this section.

PILOT.

It will be the responsibility of the pilot to ensure that the helicopter and equipment is thoroughly inspected in sufficient time prior to departure to permit correction of discrepancies without delaying the scheduled takeoff. The manner and proficiency with which each crewmember performs his related duty is the responsibility of the pilot. Therefore, the pilot must possess and maintain a thorough knowledge of each crewmember's duty and the problems related thereto. He must determine that the weight and center of gravity are within prescribed limits and thoroughly brief the crew on all particulars pertinent to the mission, ensuring that all passengers have been briefed on the operational use of emergency equipment and are familiar with warning signals and emergency procedures. The pilot must coordinate the activities of other crewmembers and the relationship of one crewmember's duty to another. The pilot is also responsible to ensure that any required debriefing is accomplished, and that required flight records, and maintenance forms are prepared.

Crew and Passenger Briefing Guide.

The following briefing guides are provided to assist the pilot in conducting briefings, as applicable to the type mission assigned.

Crew Briefing.

1. Mission requirements.
2. Flight plan.
3. Fuel load.
4. Emergency - survival equipment.
5. Weather.
6. Special equipment.
7. Weight and balance.
8. Crew duties and responsibilities.

Passenger Briefing.

When the helicopter is used to transport personnel, passengers will be briefed before and during flight, as necessary. The pilot will normally perform this duty unless delegated to the copilot or flight engineer. The briefing will cover predeparture briefing, over water briefing (when applicable). The following checklists include the items to be discussed during the briefing.

Predeparture Briefing.

1. Introduction of crew.
2. Destination.
3. Flight altitude.
4. Departure time and estimated time enroute.
5. Enroute weather.
6. Seats and safety belts. (Cover rules and demonstrate operation.)
7. Movement in the helicopter.
8. Smoking.
9. Emergency exits (location and operation).
10. Emergency landings or autorotations, (signals and exits).
11. Bailout (signals and exits).
12. Emergency equipment (fire extinguishers, crash axe, first aid kits, parachutes, and emergency exit lights).
13. Use of portable electronic device.
14. Helicopter characteristics. Passenger information card in helicopters.

WARNING

On those helicopters that lack soundproofing on the cargo compartment walls and ceiling, all passengers should wear ear protection devices to avoid ear damage.

Over Water Briefing.

If flight plan includes the crossing of any extensive bodies of water, the following items will be included in addition to the emergency procedures contained in Predeparture Briefing.

1. Use of survival equipment (life vest, rafts, etc.).
2. Escape from parachute after entering water.
3. Emergency landing (signals, positions, exits, location of first aid kits, and emergency radio).

COPILOT.

The copilot assists the pilot in mission planning by obtaining pertinent weather forecasts, intelligence reports, maps, and other related documents; assists the flight engineer in determining the cargo and passenger distribution and computing the center of gravity of the helicopter; assists the pilot in performing the exterior and interior inspections of the helicopter, and performs any additional inspection requirements deemed necessary by the pilot; assists the pilot in the operation of controls and equipment on the ground and in the air, and operates the helicopter in flight upon instructions from the pilot. The copilot should be familiar with the duties of the pilot and other crewmembers so that he may perform their duties in the absence of a complete crew complement. In the absence of crewmembers, the copilot may be called upon to perform the following duties:

1. Rescue hoist operator.
2. Litter attendant.
3. Loadmaster.
4. Lower or raise cargo sling.
5. Handle sea anchor and mooring equipment in water operation.

FLIGHT ENGINEER.

The flight engineer, at the discretion of the aircraft commander, will compute the weight and balance and complete the TOLD card. He will perform preflight duties, ensuring that the aircraft is properly serviced and that all required maintenance inspections and discrepancies have been properly cleared prior to flight. He will also determine that all mission essential and emergency equipment is aboard and properly stowed. Before taxiing he will ensure that the cargo compartment is secured for flight. During flight he will assist the pilot and copilot by observing engine instruments, circuit breakers, fuel management, warning and caution lights, fire detector indicators, electrical voltage and loads, evidence of fuel, oil and hydraulic leaks, landing gear operations and scanner duties. He will also perform the following duties:

1. Hoist Operator.
2. Raise and lower cargo sling and provide verbal instructions during cargo sling operations as necessary.
3. Cargo and/or passenger loadmaster.
4. Litter Attendant
5. Gunner.

He will report abnormal conditions to the pilot and recommend corrective action, and ascertain that aircraft limitations are not exceeded. He will ensure that the AFTO Form 781 is completed and assist in debriefing the ground crew personnel on all discrepancies noted. Away from home station, he may be required to analyze system malfunctions, perform minor maintenance repairs and maintain the AFTO Form 781. He is responsible for servicing and securing the helicopter any time when away from home station and ground crew personnel are not available. He also monitors ground movement of the helicopter and assists in mooring, etc., affiliated with water operations.

RESCUE HOIST OPERATOR.

The primary hoist operator during rescue operations is the flight engineer; however, these duties may be delegated to other crewmembers as the mission dictates.

RESCUE HOIST OPERATIONS.

Proficiency in hoist operations can be gained and maintained only by thoroughly understanding hoisting procedures and through continued practice. Moderate surface winds are an asset to hoist operations, since they increase the hovering capability of the helicopter, and if the helicopter is hovered into the wind, the weather vaning tendency of the helicopter will aid the pilot in maintaining a constant heading. Hoisting can be accomplished at night as well as day. A combination of flares and smoke may be used for night hoisting in addition to the helicopter lighting equipment. The smoke and flares, respectively, will provide a wind and target reference.

WARNING

- When scanning or conducting hoist operations at the open personnel door, the operators will wear the safety harnesses to preclude accidential exit from the helicopter. Only one personnel restraint harness will be attached to each attachment point. Personnel restraint harness will not be attached to the overhead litter strap rings.
- Static electricity may be generated by normal operation of the helicopter and will be discharged by touching the rescue hoist hook to the ground or water before attempting a rescue plckup. Do not ground the hook near spilled fuel from damaged aircraft or vehicles to prevent possible fuel ignition.
- Operation of anti-collision strobe lights during certain phases of operation (ground operation, hover, taxi, hoist operation, cargo sling, etc.) may cause hazardous distraction to personnel and the possibility of temporary vision blind spots. Therefore, consideration should be given to turning off anti-collision strobe lights (upper, lower, or both) during these operations.

Rescue Hoist Preflight Checklist (Power On).

1. Crew Position — CHECK DOWN AND UP.
   a. Inspect swivel for free rotation.
   b. Inspect allenscrew engaged in rescue hook.
   c. Run out cable if live pickups are anticipated.

d. Inspect cable for defects.

e. Observe Hoist Drum, level wind and feed rollers for proper operation.

f. Check limit switches for proper operations.

2. Pilot's Position — CHECK DOWN AND UP.

3. Manual override — CHECK.

4. Hoist Operator's ICS — CHECK HOT MIKE.

5. Hoist and Equipment — STOW.

SMOKE/FLARE DROP CHECKLIST.

1. Safety harness — ON, ADJUSTED.
2. Interphone Control — SET.
3. Gloves — ON.
4. Door — OPEN.
5. Smoke/Flare device — PREPARED.
6. Smoke/Flare drop checklist — "COMPLETED" (FE).

HOIST OPERATOR'S BEFORE PICKUP CHECKLIST.

1. Safety harness — ON, ADJUSTED.
2. Cabin interphone control — SET.
3. Gloves — ON.
4. Door — OPEN.
5. Hoist master switch — "CREW" (P).
6. Anti-Collision strobe lights — AS REQUIRED.
7. Hoist — CHECKED.
8. Rescue device — ATTACHED.
9. Hoist operator's before pickup checklist — "COMPLETED AND READY FOR PICKUP, ACKNOWLEDGE." (Hoist operator will use HOT MIKE for this response.)

NOTE

The pilot and copilot will acknowledge Hot Mike operation.

HOIST OPERATOR'S AFTER PICKUP CHECKLIST.

1. Survivor — "IN AND SECURE, READY FOR TAKEOFF." (FE)
2. Hot mike — OFF.
3. Hoist and cabin — SECURE.
4. Anti-Collision strobe lights — AS REQUIRED.
5. Hoist master switch — "OFF, AFTER PICKUP CHECKLIST COMPLETED." (FE)

GUNNER'S OPERATING PROCEDURES.

The following instructions are provided for the performance of all normal aircrew procedures, from the time the aircrew reports to the loaded aircraft until after landing.

PREFLIGHT.

1. Applicable exits — OPEN.

2. Gun mounts — FIRING POSITION.

   Remove pins position mounts and guns into firing position. Lock in place with pins.

3. Weapon — SAFE.

   a. Safety button — S (Safety).

   b. Cover assembly — Open.

   c. Check chamber — EMPTY.

   d. Cover assembly — CLOSED.

4. Weapon — SERVICEABLE.

   a. Barrel lock lever — Locked.

b. Gun components — Installed and secure.

5. System components — INSTALLED AND SECURE.

a. Gun mount — SERVICEABLE AND PROPERLY INSTALLED.

b. Gun stops — CHECK PROPER FIELD OF FIRE.

WARNING

Visually inspect cam stop for wear and confirm that cam follower will not override cam stop to ensure that no portion of the aircraft can be brought into the gun's field of fire.

c. Expended brass chute — SERVICEABLE AND SECURE.

6. Gun — STOWED.

Remove pins and position mounts and guns in stowed position. Lock in place with pins. To stow guns and mount, reverse procedures in Steps 1 and 2.

7. Ammunition — CHECKED AND SECURED.

Check type, quantity and proper loading in ammo can.

ARMING.

1. Personnel harness — CHECKED AND ON. Properly adjusted and safety pin installed.

2. Helmet visor/goggles — DOWN/ON.

3. Guns — FIRING POSITION. Place guns and mounts in firing position in accordance with preflight procedures.

WARNING

The door weapon will normally be stowed when personnel are entering or exiting the aircraft.

CAUTION

On CH-3E Aircraft modified for armament, the left forward cabin window will only be removed or installed while the aircraft is on the ground.

4. Gunners — LEFT, RIGHT, AFT GUNNER - REQUEST PERMISSION TO ARM GUN.

a. Safety lever — F (Firing).

b. Expended brass chute — AS REQUIRED.

c. Cocking lever — PULL COCKING LEVER FULL AND PUSH FULL FORWARD.

d. Safety lever — S (Safety).

e. Expended brass chute — SECURE.

WARNING

Weapons fired without the expended brass chute installed will cause damage to the aircraft's rotor blade system.

f. Latch lever — TURN AFT AND RAISE COVER.

CAUTION

Do not turn latch lever more than required to unlock the cover, as damage to the latch spring will result.

g. Ammunition — POSITION ON FEED TRAY. (See figure 8-1.)

h. Latching cover — CLOSE.

5. Gunners — Report by position; i.e., left gun, right gun, aft gun — "GUN ARMED AND READY TO FIRE."

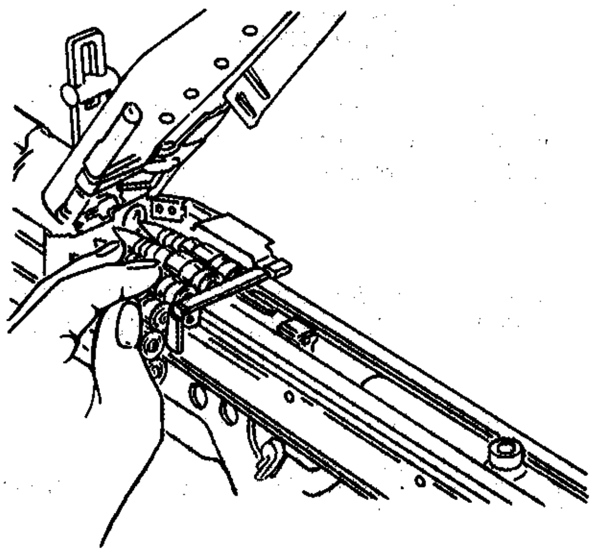

Figure 8-1. Arming Gun

FIRING.

1. Gunner — REQUEST PERMISSION FROM PILOT TO FIRE.

2. Safety lever — F (Firing).

3. Guns — FIRE AS NECESSARY.

WARNING

The gun safety button should only be placed on FIRE immediately prior to firing, and then turned to SAFE immediately upon cease firing to preclude any unintentional firing. Keep weapon pointed in a safe direction.

DE-ARMING.

1. Cover assembly — OPENED.

2. Chamber — CLEAR.

3. Safety button — S (Safety).

4. Feed chute/ammo — REMOVE.

CAUTION

Before stowing, wait 5 minutes to allow the barrel/chamber to cool.

NOTE

Leaving the bolt assembly in the open position will aid in heat dissipation in the chamber area and ensures an opening for visual inspection while safing the weapon.

5. Gunners — Report by position; i.e., left gun, right gun, aft gun — "SAFE AND CLEAR"

6. Cover assembly — CLOSED.

7. Guns and mounts — STOW.

FLARE EJECTOR SET OPERATING PROCEDURES.

Any or all crewmembers (up to six) can operate the flare ejector set at one time. The six flare firing points are:

1. Pilot's cyclic stick.

2. Copilot's cyclic stick.

3. Flare programming control panel.

4. Left side flare release panel.

5. Flight engineer's panel.

6. Ramp observer flare release panel.

All presets are made at the control panel. The number of flares per burst, the number of bursts for each firing initiated, and the time interval between bursts must be set on the control panel for mission requirements as instructed by the pilot.

Set the control panel BURSTS REMAINING indicator for total number of flares loaded divided by the control panel FLARES PER BURST switch setting. Settings are as follows:

PREFLIGHT.

1. All flare ejector set circuit breakers — CLOSED.

2. Control panel — SET.

   a. FLARES PER BURST switch — AS REQUIRED.

b. BURST SELECTOR — AS REQUIRED.

c. INTERVAL SELECTOR — AS REQUIRED.

d. BURSTS REMAINING — TO NUMBER OF BURSTS LOADED.

e. TRANSFER/OFF switch — OFF.

f. POWER/OFF switch — OFF.

g. AUTO/OFF switch — AUTO.

ARMING.

1. Pilot's AN/ALE-20 ARMING SWITCH — ON.

2. Control panel POWER/OFF switch — POWER.

FIRING.

Upon missile sighting, press the release button at any release position; all release buttons are wired in parallel so that any crewmember observing an enemy missile launch can release a flare. Pressing the FAST TRAIN button on the control panel fires a flare every 65 milliseconds until all flares are released.

NOTE

No programming controls shall be adjusted during the execution of a flare program.

DE-ARMING.

1. Pilot's AN/ALE-20 ARMING SWITCH — OFF.

2. Control panel POWER/OFF switch — OFF.

CARGO SLING PREFLIGHT CHECKLIST (POWER ON)

If sling operations are planned, check for proper rigging and operation of all release mechanisms.

1. Cargo Sling Switch — "SLING" (CP, FE).

   Position a Flight Engineer or Fireguard at the cargo hook.

2. Pilot's Electrical Release — "CHECKED" (P, FE/FIREGUARD).

Approximately 20 pounds of tension is required on the load beam to open the hook. Any excessive pressure or binding should be investigated prior to flight.

3. Co-Pilot's Electrical Release — "CHECKED" (CP, FE/FIREGUARD).

4. Cargo Sling Switch — "SAFE" (CP, FE).

With switch in safe position, pilot and co-pilot should recheck their electrical releases. The hook should not open.

5. Pilot's Emergency Release Pedal — "CHECKED" (P) "CHECKED OPEN" (FE/FIREGUARD).

WARNING

Operation of the pilot's cargo emergency release pedal should be smooth with no binding and should return to full up position. If pedal does not return to full up position, a positive latching cannot be assured. The cargo sling will not be used with a malfunction in any of the release modes.

6. Cargo Hook Manual Release — "CHECKED" (FE/FIREGUARD).

7. Cargo Sling Preflight Checklist "COMPLETED" (FE).

CARGO SLING PRE-PICKUP CHECKLIST.

1. Power Available Check — "COMPLETED" (P).

2. Crew/Ground Personnel — "BRIEFED AS REQUIRED" (P).

3. Cargo Sling — "LOWERED" (FE).

4. Safety Harness — ON AND ADJUSTED (FE).

5. Cargo Door — OPEN (FE).

6. Sling Master Switch — "SLING" (CP).

7. Lower Strobe Light — "AS REQUIRED" (CP).

8. Cargo Sling Checklist — "COMPLETED" (FE).

AFTER RELEASE CHECKLIST

1. Cargo Sling — "STOWED" (FE).

2. Sling Master Switch — "SAFE" (CP).

3. Lower Strobe Light — "AS REQUIRED" (CP).

4. After Release Checklist — "COMPLETED" (FE).

NOTE

Normally the cargo hook will only be lowered and raised while in a hover. At no time will the helicopter be taxied with the hook in the lowered position.

SECTION IX

ALL-WEATHER OPERATION

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INTRODUCTION.

This section contains those procedures that differ from or are in addition to the normal operating procedures outlined in Section II, except where repetition is necessary for emphasis, clarity, or continuity of thought.

INSTRUMENT FLIGHT PROCEDURES.

Flight in this helicopter, during instrument conditions, is comparable to fixed-wing instrument flight. The AFCS provides stable flight characteristics which are desirable for instrument flight. An instrument qualified helicopter pilot can safely perform instrument flight and approaches.

PREPARATION FOR INSTRUMENT FLIGHT.

Complete the normal inspection outlined in Section II of this manual. Particular attention should be given to anti-icing system, pitot heat, windshield wipers, lighting, instrument systems, and navigational aids for proper operation.

WARNING

In cold weather, make sure all instruments have warmed up sufficiently to ensure normal operation. Check for sluggish instruments during taxiing.

INSTRUMENT TAKEOFFS.

In addition to these conditions which normally require an instrument takeoff, (e.g. precipitation, low ceilings, and night takeoffs), helicopter induced restrictions to visibility, such as dust or snow blown by the rotor downwash, may require an instrument takeoff. There are two recommended instrument takeoff techniques; the normal and the running takeoff. The running takeoff is recommended when there is insufficient power to perform the normal instrument takeoff. The attitude indicator should be adjusted by setting the pitch and roll adjustment knobs at the zero trim dots to assure that when the helicopter is flown, the correct attitude indications will be given. Attitude indicator may be readjusted during climb and cruise.

Normal Instrument Takeoff.

The normal instrument takeoff may be made either from the ground or from a hover. Align the helicopter with the desired takeoff heading and crosscheck the heading indicator. Advance the throttles to maximum N_r. Smoothly increase collective pitch to obtain a positive climb rate. Then change pitch attitude to a 3-degree nose low indication and maintain a level bank attitude. Maintain this attitude and crosscheck the vertical velocity indicator and altimeter for positive climb indications while accelerating to 70 KIAS. Then raise the nose slowly to a noseup indication of approximately 3 degrees, reduce collective pitch to obtain desired climb power, and adjust attitude to maintain desired climb airspeed.

WARNING

Do not attempt to hover the helicopter under actual instrument conditions. Instrumentation is not adequate to safely accomplish this maneuver.

Running Instrument Takeoff.

This takeoff is similar to a visual running takeoff. Align the helicopter with the takeoff direction and crosscheck the heading indicator. Advance throttles to maximum N_r. Begin takeoff roll, accelerating to 35-40 KIAS. Move the cyclic stick aft, as necessary, while increasing collective pitch to obtain power for takeoff. As the helicopter leaves the ground, establish a 3 degree nose low pitch attitude, and proceed as in a normal instrument takeoff.

CAUTION

The helicopter may have a tendency to leave the ground in a slightly nosedown attitude. Care should be exercised to avoid striking the nosewheel on the ground.

INSTRUMENT CLIMB.

Climb under instrument conditions is similar to the climb technique and procedures outlined in Section II for normal conditions. Recommended climb speed is 70 - 80 KIAS with maximum continuous power, or military power, if required. Standard rate turns are recommended below approximately 6000 feet MSL. At higher altitudes, half standard rate turns are recommended. Turns should be limited to a maximum bank angle of 30 degrees. For short duration climbs during cruise, increase collective pitch to obtain desired climb rate while maintaining cruise airspeed.

INSTRUMENT CRUISE.

Conduct instrument cruise flight as in normal flight procedures outlined in Section II. Instrument cruise airspeed should be established in a speed range where vibrations are at a minimum. Refer to the Appendix, as necessary, to determine best cruise airspeeds. A minimum speed of approximately 70 KIAS should be observed to maintain normal flight characteristics associated with forward flight. Cruising flight turns should be limited to bank angle of 30 degrees. Standard rate turns are recommended below approximately 6000 feet MSL. At higher altitudes, half standard rate turns are recommended.

RADIO AND NAVIGATION EQUIPMENT.

Radio and navigation equipment is operated in the normal manner.

WARNING

Operate the gyro select switch during level flight only; switching gyros during a bank could result in a severe roll.

HOLDING.

If delays are anticipated, fuel may be conserved by reducing power, as desired, or by establishing maximum endurance cruise.

DESCENT.

Normal enroute descents or radar descents to traffic altitudes are made at cruise airspeeds. Adjust power, as required, to obtain the desired rate of descent.

NOTE

If an emergency or other occasion requires expeditious descent, the following procedure may be used:

1. Reduce collective as much as possible, but not to exceed N_r limits, and lower the landing gear, if desired.

2. Maintain cruise airspeed (if desired). Airspeed may be increased but not to exceed the maximum airspeed limitation in Section V.

3. Initiate recovery approximately 500 feet above the assigned or desired altitude.

INSTRUMENT APPROACHES.

Use standard instrument approach procedures. Utilizing cruise airspeeds throughout the approach will reduce the effects of wind.

WARNING

For single engine approach maintain cruise speed, if possible. Do not let airspeed fall below 70 knots. Operation at lower speeds can result in loss of altitude at higher gross weights and missed approaches may not be possible.

NOTE

Instrument approaches with one engine inoperative will normally be the same as a two-engine approach except for a possible reduction in airspeed. With auxiliary servo off, use maximum of 100 knots and 1/2 standard rate turns.

VOR/ADF/Range Approach.

Accomplish these approaches in accordance with figure 9-1.

Radar Approach.

Accomplish a radar approach in accordance with figure 9-2. Single engine radar approach procedures are included in figure 9-2. This emergency approach should use a 5 mile final approach to landing. Maintain an airspeed of 70 KIAS to ensure single engine capability.

TACAN and ILS Approaches.

(See figures 9-3 and 9-4.)

Missed Approach Procedure.

If a missed approach is necessary, increase power as required to obtain the desired rate of climb while establishing desired airspeed. Continue climb to missed approach altitude as published or as instructed by approach control and accomplish AFTER TAKEOFF check.

ICE AND RAIN.

WARNING

To preclude the possibility of engine failure due to ice ingestion, the foreign object deflector shield must be installed prior to flight in known or forecast icing conditions, or visible moisture at or below 5°C. Without the foreign object deflector installed, minimize flight in icing conditions inadvertently encountered.

ICE.

Encountering icing in flight may result in loss of forward visibility, serious loss of lift and loss of rotor efficiency. Ingested ice can cause engine damage. Asymmetrical shedding of ice from rotor blades can cause large amplitude vibrations.

WARNING

- Do not attempt flight in freezing rain. Flight in icing conditions exceeding trace icing is not recommended unless contrahesive polyethelene anti-icing tape is installed on the main rotor blades. Flight in known light icing conditions is permitted if the tape is installed.
- Ice may form on rotor system without other visible signs of icing.

CAUTION

Minimize flight in icing conditions without anti-icing tape installed to avoid rotor blade damage.

The greatest dangers caused by ice accumulation are lowered rotor blade efficiency and loss of engine power. Ice accumulation accelerates blade stall, reduces rate-of-climb capability, and increases power requirements, thus increasing fuel consumption and decreasing range and endurance, and may impair control response and reduce engine power by obstructing the engine air inlet area. Icing of the engine inlet area is an ever present possibility when

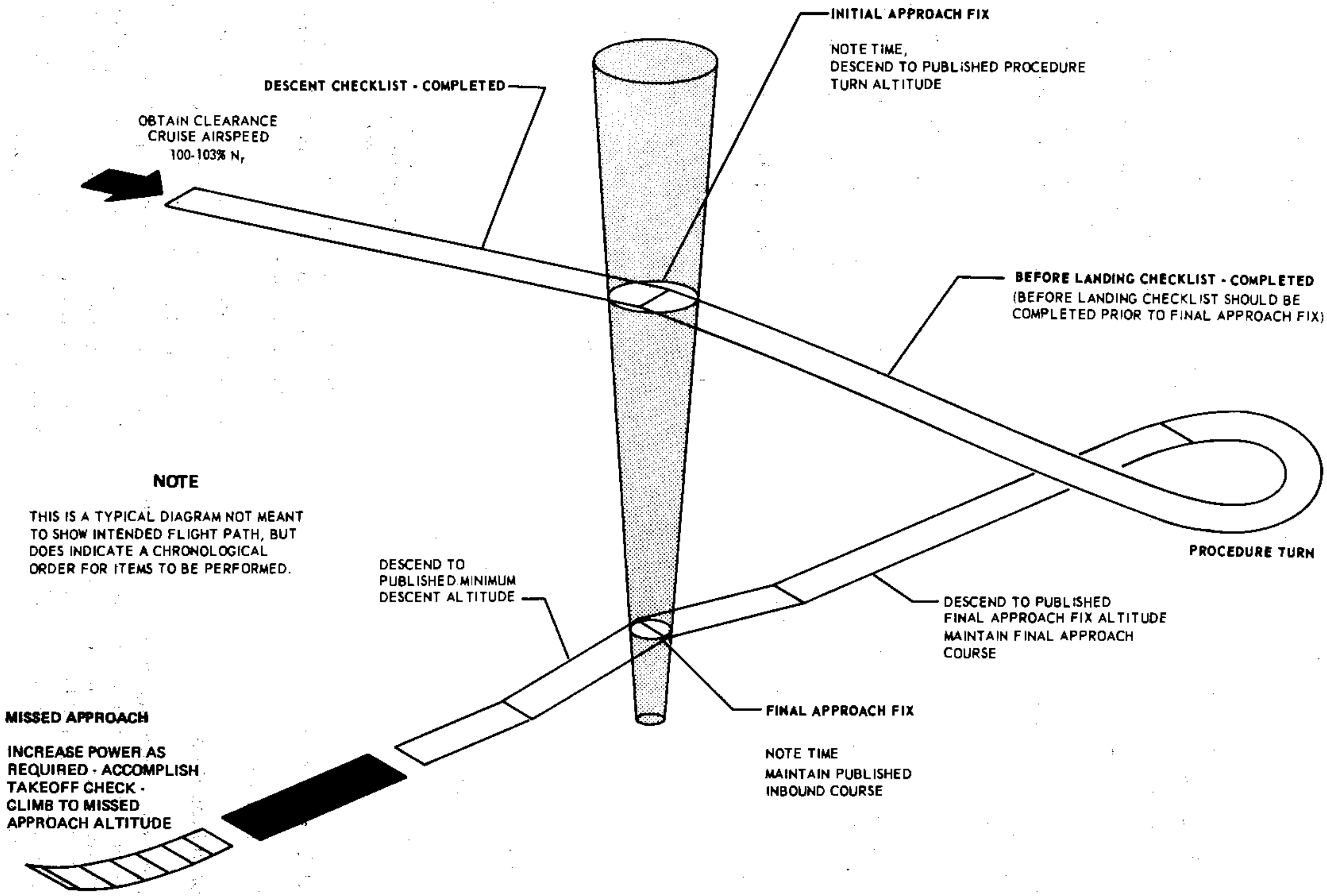
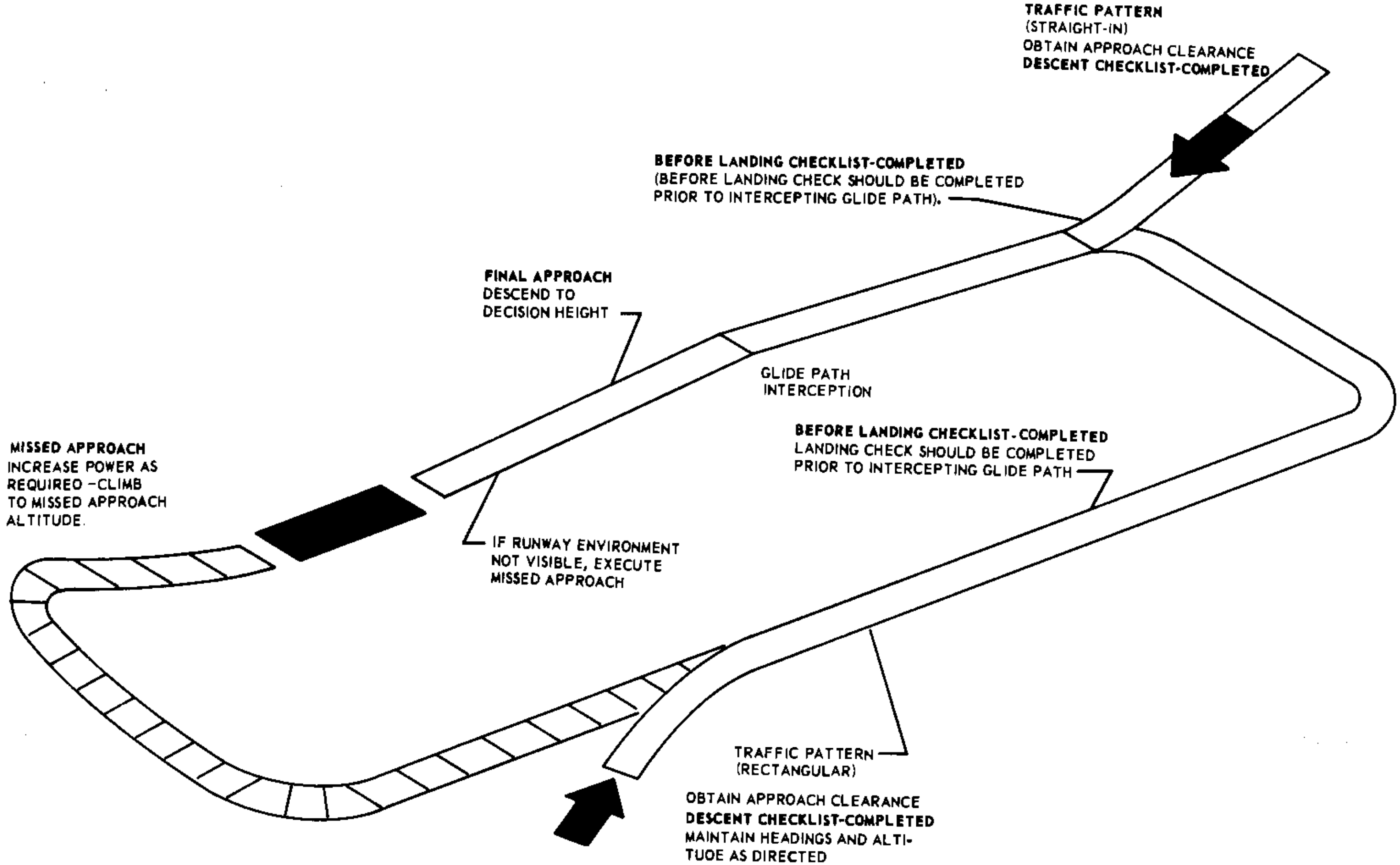


Figure 9-1. Range, ADF, VOR Approach (Typical) (Normal and Single Engine)



NOTE

THIS IS A TYPICAL DIAGRAM, NOT MEANT TO SHOW INTENDED FLIGHT PATH, BUT DOES INDICATE A CHRONOLOGICAL ORDER FOR ITEMS TO BE PERFORMED

Figure 9-2. Radar Approach (Typical) (Normal and Single Engine)

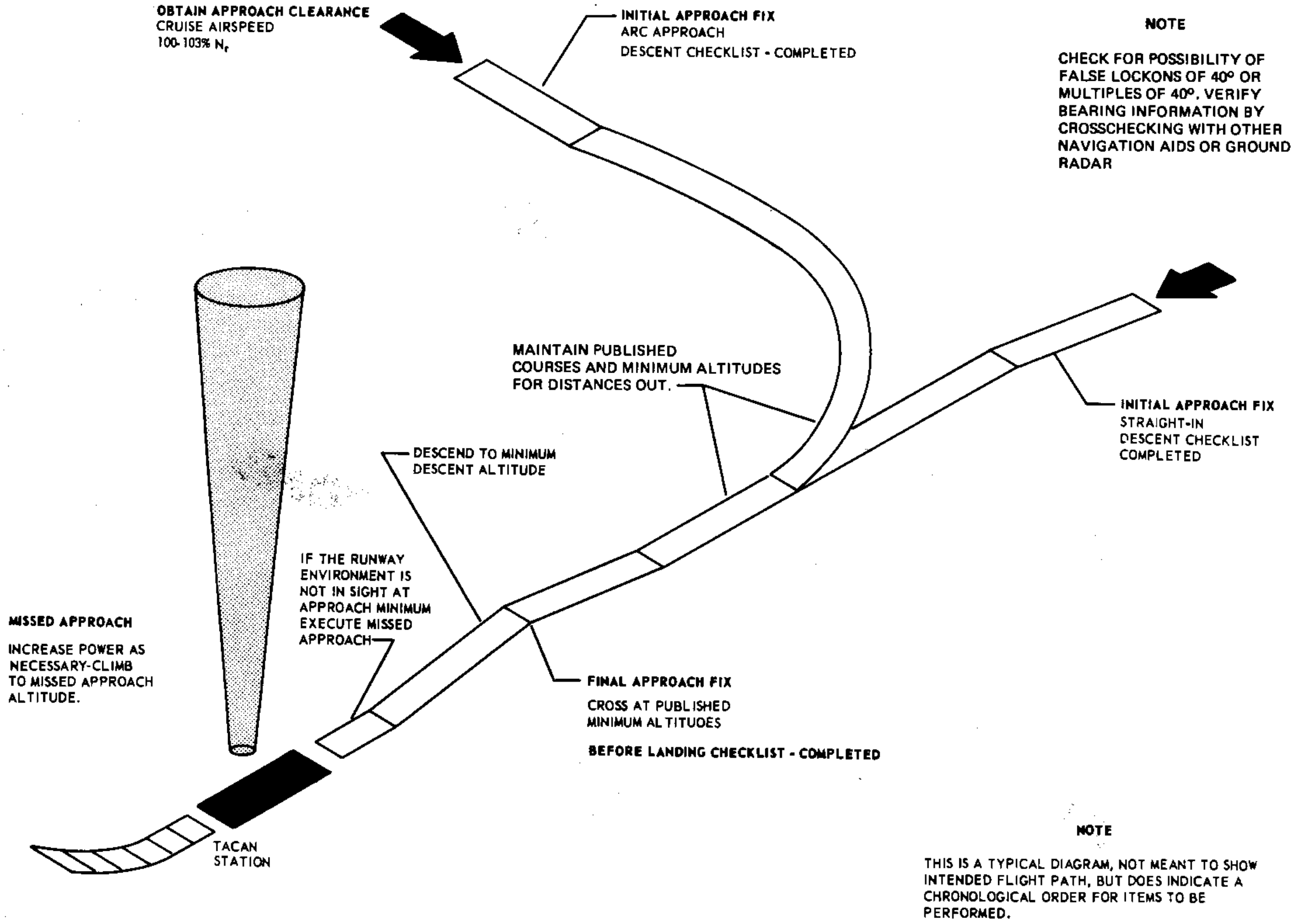


Figure 9-3. Tacan Approach (Typical) (Normal and Single Engine)

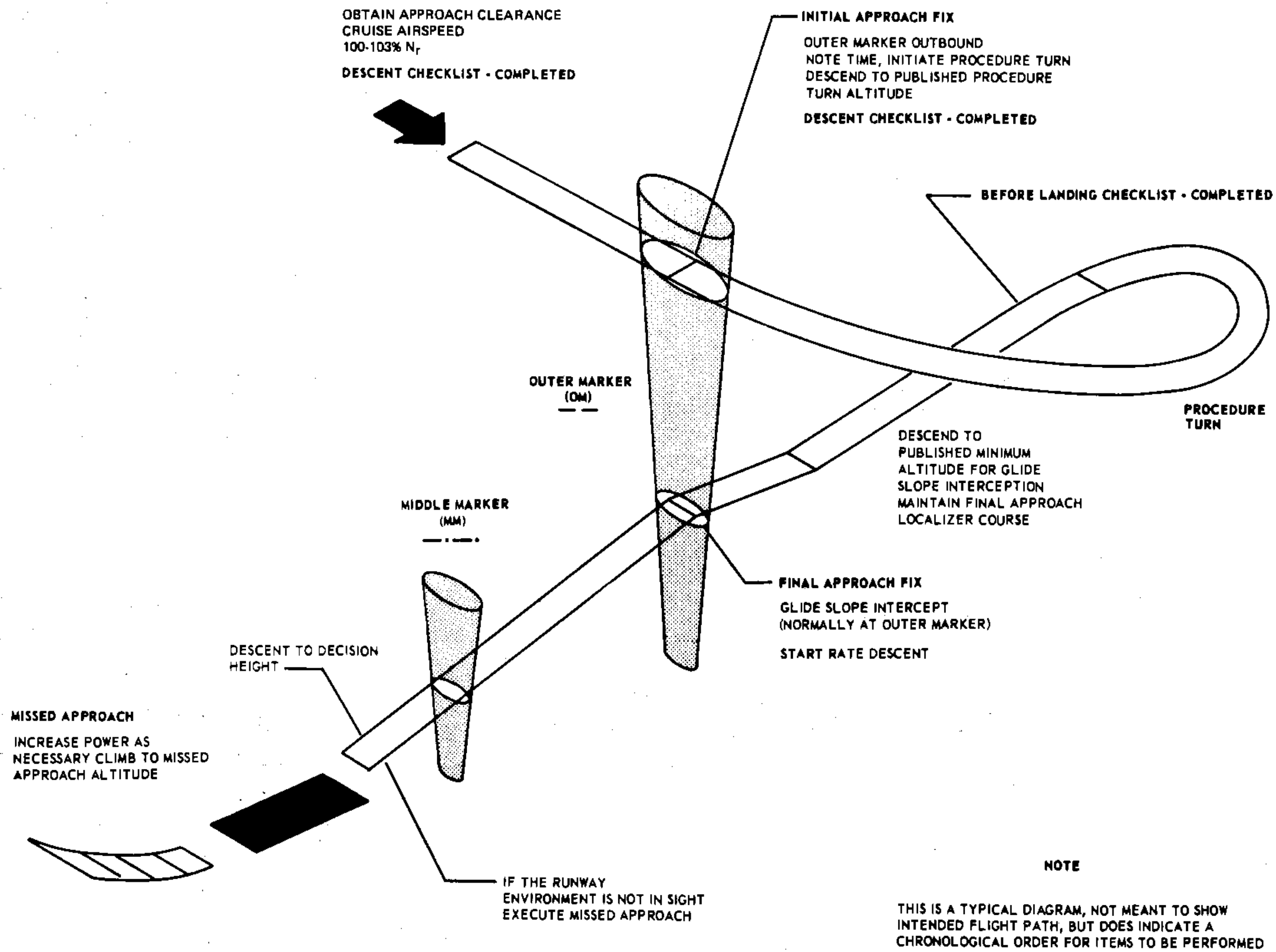


Figure 9-4. ILS Approach (Typical) (Normal and Single Engine)

operating in weather with temperatures near the freezing point. Engine inlet icing is more prevalent when ambient temperatures are below 10°C. The engine inlet anti-icing system should be operated continuously during all conditions when ice may be encountered. A loss of gas generator speed and a rise in power turbine inlet temperature is indicative of engine icing. Engine inlet icing does not necessarily occur with blade icing.

Exterior Inspection.

Check the lower section of the engine air inlet for evidence of ice. Moisture, collected on the previous flight, can accumulate in the lower section and freeze. An attempted engine start could cause damage. If ice is suspected, check the engine to ensure it is free to rotate. If the engine is not free to rotate, external heat must be applied to the forward engine section to permit thawing. Start the engine as soon as possible after thawing to remove all moisture before refreezing can occur. Check that the helicopter surfaces, controls, pitot tubes, static ports, ducts, blades, and oleo shock struts are free from ice.

WARNING

Remove all ice accumulations prior to flight. Snow, frost or light ice (up to 1/16 inch) can be removed from the aircraft and rotor blades by normal runup. A brush may be used as an alternate method. Moderate and severe ice accumulations will be removed in accordance with appropriate maintenance technical data instructions.

Rotor Engagement.

CAUTION

The helicopter may yaw on ice due to the lack of tail rotor control at low rpm when rotors are first engaged. Under these conditions the helicopter should be properly secured or moved to a dry area.

Taxiing.

When it is necessary to taxi on ice covered surfaces, use slow ground speeds so that cyclic stick displacement may be used as the primary braking force.

Takeoff.

The pilot must ascertain that the helicopter wheels are not frozen to the surface. A slight yawing motion, induced by light tail rotor pedal motion, should break the wheels free when they are frozen to the surface. Takeoffs into fog or low clouds, when the temperature is at or near freezing, could result in engine inlet icing. Rate of climb speeds should be higher than normal under such conditions.

DURING FLIGHT.

During icing conditions, the main rotor assembly and rotor blades will collect ice. After a sufficient amount has collected, vibration may be noted in the controls and the airframe. Occasionally rotor vibration may be experienced due to shedding of ice that has accumulated on the blades. Shedding may be detected in cruise by light rotor vibrations accompanied by a decrease in torque and an increase in airspeed. Engine inlet icing may also be encountered, but not necessarily concurrent with rotor blade icing. When icing is present during low altitude flights or approach, additional power will be necessary to maintain safe flight. Also, do not lower the landing gear until in the landing pattern to avoid excessive ice accumulation on the landing gear and exposed components. Use the heater, as required.

WARNING

When engine inlet icing is detected, change altitude immediately to leave the icing layer. Reduce power as necessary to maintain normal power turbine inlet temperatures.

LANDING.

Accomplish a normal landing, but if icing is present, increased power may be necessary to ensure a safe landing. If power requirements become critical, and terrain permits, a running landing should be accomplished. When shutting down the rotors on ice, extreme caution should be used when applying the rotor brake to preclude inducing a yaw. If possible, select a dry area to shut down. If not possible, have the nosewheel secured and apply only small amounts of rotor brake until the rotor is stopped.

RAIN.

Heavy water ingestion into the engines will cause the steady-state fuel requirements to increase appreciably. Gas generator speed will decrease, accompanied by a reduction in power output, when abnormally heavy water ingestion causes the engine steady-state fuel requirements to exceed the fuel controls ability to maintain gas generator speed. Gas generator speed may or may not stabilize at some lower level, depending upon the amount of water being ingested. The emergency fuel control lever can be used to stabilize gas generator speed and restore power within the limits of the maximum fuel flow of the fuel control.

NOTE

Rain on the windshield will reduce visibility whether the windshield wipers are operating or not.

TURBULENCE AND THUNDERSTORMS.

The helicopter handles very well in light to moderate turbulence. As turbulence levels increase, cruise airspeeds should be reduced for comfort, ease of control, and reduced blade stall effects. If thunderstorms or turbulence cannot be avoided, the following procedures should be followed:

NOTE

If aircraft is flown through moderate turbulence an Aircraft Forms entry is required.

1. BAR ALT - OFF.

2. Attitude: The key to proper flight technique through turbulence is attitude. Both the pitch and bank should be controlled by reference to the attitude indicator (ADI). Do not change trim after the proper attitude has been established. Extreme gusts will cause large attitude changes. Use smooth and moderate cyclic inputs to reestablish the desired attitude. To avoid overstressing the helicopter, do not make large or abrupt attitude changes.

3. Airspeed: Adjust power to establish a speed of approximately 80 KIAS. Trim the helicopter for level flight at this speed and apply enough friction to hold collective in place. Severe turbulence will cause large and rapid variations in indicated airspeed. Do not chase the airspeed.

4. Altitude: Severe vertical gusts may cause appreciable altitude deviations. Allow altitude to vary. Sacrifice altitude to maintain the desired attitude. Do not chase the altimeter.

CAUTION

Flights through thunderstorms or other areas of extreme turbulence must be avoided whenever possible. Maximum use of weather forecast facilities, and air or ground radar, to aid in avoiding thunderstorms and turbulence are essential. If a storm cannot be avoided, and a landing is practical, land and wait for the storm to pass.

NOTE

- The AFCS barometric altitude channel should be disengaged to prevent possible damage to the barometric altitude controller, if strong updrafts or downdrafts cause the helicopter to be displaced more than 200 feet from the engaged altitude.
- When lightning is encountered at night, the dome light, spotlight, and instrument lights should be turned to full intensity to preclude temporary blindness.

LIGHTNING STRIKES.

Although the possibility of a lightning strike is remote, with increasing use of all-weather capabilities the helicopter could inadvertently be exposed to lightning damage. Therefore, static tests were conducted to determine lightning strike effects on rotors. Simulated lightning tests indicated that lightning strikes may damage helicopter rotors. The degree of damage will depend on the magnitude of the charge and the point of contact. Catastrophic structural failure is not anticipated. However, damage to hub bearings, blade pockets, and blade tips was demonstrated. Also, adhesive bond separations occurred between the blade spar and pockets and between the spar and leading edge abrasion strip. Some blade pockets deformed to the extent that partial or complete separation of the damaged sections could be expected. Such damage can aerodynamically produce severe structural vibration and serious control problems which, if prolonged, could endanger the helicopter and crew. If lightning damage occurs, as indicated by control problems or vibration changes, especially abnormal noise, the pilot's assessment of the extent of damage, the mission requirements, and the demands of the current flight situation will determine the required action.

WARNING

Avoid flight in or near thunderstorms especially in areas of observed or anticipated lightning discharge.

NOTE

Abnormal operating noises almost always accompany rotor damage, but loudness or pitch is not valid indication of damage sustained.

1. If a lightning strike occurs but there are no indications of damage to the helicopter, the following precautions are recommended to minimize risk:

   a. Reduce airspeed as much as practical to maintain safe flight but keep power on and maintain normal N_r.

   b. Land as soon as practical. Descend with partial power avoiding abrupt control inputs.

   c. Do not autorotate but accomplish precautionary landing, shutdown, and visually inspect rotors for damage before proceeding.

   d. Record suspected lightning strike in maintenance forms.

2. If lightning damage is suspected but vibration is slight and no control problems appear, land as soon as possible. Avoid unnecessary delay in landing to assess damage.

3. If lightning damage is moderately serious, an immediate emergency landing is recommended.

4. In the event severe lightning damage makes the helicopter difficult or impossible to control, make an emergency landing or bailout.

NIGHT FLYING.

Night flying does not present any additional instrument flight problems, but does add the physical problems of illumination of cockpit instruments and interior and exterior reflections. Exterior lights may reflect on surrounding clouds to hamper night adaptation and make instrument reading difficult.

WARNING

The forward rotating anti-collision light may be turned off when flight conditions cause the pilot to experience spatial disorientation as a result of the reflections of the rotating light against the clouds, dust, water spray, etc.

TAKEOFF PROCEDURE.

There is basically little difference in the technique used on night takeoffs from that used in day operations. Care should be exercised to make a clean decisive break from the ground to a safe hovering altitude. The landing lights should be used to illuminate the ground. The effectiveness of the landing light improves as the helicopter is brought to a hover. The use of search or floodlights is discretionary witb the pilot as he can best judge conditions. The landing light should be positioned for immediate use in the event of an emergency. The searchlight provides good illumination and gives less reflections from a runway for takeoffs and landings.

LANDING PROCEDURE.

In poorly lighted or unlighted areas, the searchlight can be used to clear the landing area prior to landing. Use care to correct for side drift before contacting the ground.

WARNING

- Rotation of the searchlight while the helicopter is in a hover may cause the pilot to become spatially disoriented because the light does not rotate in a level plane.
- Night approaches into unlighted areas over smooth, featureless terrain such as water, snow, dry lake beds and salt flats can result in complete loss of depth perception and inadvertent ground contact.

COLD WEATHER PROCEDURES.

The major problems in cold weather operations are the preparation for flight, restricted visibility from blowing snow, and the adverse effects on helicopter materials. Moisture, usually from condensation or melted ice, may freeze in critical areas. Tire, landing gear strut, fire extinguisher bottle, and accumulator air pressures will decrease as the temperatures decrease. Extreme diligence on the part of both ground and flight crews is required to ensure successful cold weather operation. Icing conditions are not considered in this discussion, as they are covered under ICE AND RAIN, in this section. The problems encountered when operating from snow-covered surfaces are compounded when operating from other than an operational air base. The restricted visibility caused by blowing snow can be partially overcome by utilizing smoke grenades or some other object distinguishable in color (such as pine boughs, painted jerry can, or emergency kit), placed in the landing area for reference. The smoke grenade will reveal the wind direction and allow an estimate of its speed. The danger of breaking through snow crust is minimized by maintaining maximum rpm when resting on an unknown snow surface. Pilots should be aware that the horizon may be lost when flying over large unbroken expanses of snow. If such a situation exists, the helicopter should be flown entirely by instruments at a safe instrument altitude. Colored glasses should be worn in snow areas to prevent snow blindness.

WARNING

Static electricity generated by the helicopter should be dissipated before attempting a sling or hoist pickup, particularly in colder dry climatic conditions when static electricity buildups are large. To dissipate this static charge, allow the sling or hoist to touch the ground, or use a conductor to make contact between the helicopter and the ground.

NOTE

- Hoist and sling operations are possible under loose or powdery snow conditions, provided normal precautions for maintaining ground references under low visibility are followed.
- Human efficiency is reduced sharply as temperature drops below -18°C. In arctic and subarctic operations, rotor wash is known to have a super-cooling effect which may reduce the efficiency of exposed personnel as much as may be expected by a 11°C drop in temperature. Consequently, the time that survivors and/or ground personnel are exposed to rotor wash should be held to a minimum.

PREPARATION FOR FLIGHT.

In addition to accomplishing a normal exterior inspection, the rotor head, main rotor blades, tail rotor, and flight controls should be thoroughly inspected and be free of all ice and snow. Failure to remove snow and ice accumulations while on the ground can result in serious aerodynamic and structural effects when flight is attempted. It is recommended that ice chocks be used on the landing gear wheels due to the minimum traction afforded on snow and ice surfaces. Check that fuel tank vents, static ports, and pitot tubes are free of snow and ice; that landing gear struts, tires and hydraulic accumulators are properly inflated; and that a warm well-charged battery has been installed. Manually check compressor rotors for freedom of rotation. If ice or snow is found, the engine should be thawed out with hot air prior to attempting to start.

CAUTION

- If the ambient temperature is below -29°C, do not rotate the rotor head by hand, as damage to the main transmission may result.
- Do not attempt to chip or scrape snow and ice from any surfaces or controls. Portable ground heaters or deicing fluid may be used to remove any accumulation that cannot be swept off.

STARTING APU ENGINE.

When operating at extremely low temperatures, it will be necessary to have the dual APU accumulators installed to facilitate APU turbine engine starts. The amount of pressure required for a start increases as the temperature decreases. At -54°C a pressure of approximately 4000 psi is required to start the turbine engine.

WARMUP AND GROUND TESTS.

Immediately after APU start, turn on the cabin heater, engine inlet anti-icing, pitot heat, and windshield anti-ice systems. Check the transmission oil pressure and temperature. The flight controls will be checked prior to rotor engagement. During cold weather conditions, condensed moisture which accumulates in the primary servos may freeze, resulting in a flight control restriction and/or servo hardover. If a frozen control condition is suspected, operation will be terminated and discrepancy annotated in the AFTO Form 781 for maintenance inspection/action.

WARNING

Aircraft damage and personnel injury can result if rotor is engaged with a flight control restriction or servo hardover condition.

CAUTION

- Allow a longer warmup period during cold weather due to the time required to bring engine and transmission oil temperatures up to desired operating range. Operate the APU until the main transmission oil temperature gage indicates -15°C before rotor engagement is accomplished. As an example, at a transmission temperature of -37°C, an APU run of approximately 4 minutes is required. At extremely low temperatures, heating by circulating oil with the APU may not be adequate. In this case, apply external heat as directed under Engine Start and Rotor Engagement Procedures with APU Inoperative (Below -6.7°C) in this section. In the event of a rotor brake failure, do not start engines until this warmup period is completed to prevent damage to the main transmission.
- When starting the APU with ambient temperatures below -29°C, the APU should be shut down if the clutch hangs up more than 6 seconds or if the total starting time is more than 18 seconds. Refer to BEFORE STARTING ENGINES in Section II.

ENGINE STARTING.

At extremely low temperatures, it is possible that the engine oil pressure will go to a maximum value or actually peg-out on the gage during an engine start. If oil pressure does not return to within operating limits within 30 seconds after reaching ground idle, shut down the engines and investigate. Ensure that ground heater ducts have been removed; then accomplish normal engine start as outlined in Section II. If there is no indication of oil pressure after 30 seconds of engine operation at ground idle, or if oil pressure drops to zero after a few minutes of ground operation, stop engines and investigate.

Engine Start and Rotor Engagement Procedure With APU Inoperative (Below -6.7°C).

When the ambient temperature is -6.7°C or less, and the APU is inoperative, proceed as follows:

1. Install a heavy canvas cloth or equivalent over the main transmission area to form a heat barrier (optional).

2. Lower the right and left transmission service platforms, keeping all other service platforms and access panels closed.

3. Utilizing two H1 400,000 BTU heaters (or equivalent) with 12-inch ducts, direct one heater outlet to each side of the lower portion of the main transmission housing until the main transmission oil temperature indicates -6.7°C, or warmer, and heat has been applied for the following listed time periods.

Ambient temperature	Time duration
-37°C or warmer	5 min
-43°C	10 min
-48°C	15 min
-54°C	20 min

NOTE

These times are based on heater duct outlet temperatures of 93 ± 14°C. If outlet temperature is different than this, or if only one heater is available, additional heating may be required.

4. After the above preheat is accomplished, start either engine with rotor brake off. (Refer to Engine Start and Rotor Engagement With APU Inoperative in Section VII.) When oil pressure stabilizes and the transmission oil temperature gage maintains an indication of -6.7°C or warmer, rotor speed may be slowly increased to 100% N_r.

TAXIING INSTRUCTIONS.

The helicopter can be taxied in soft snow. The deeper the snow, the more difficult taxiing and steering may become, and increased collective pitch may be necessary. Helicopters should not be taxied on a snow-covered surface that is suspected or known to contain hidden obstructions or hazards. Normally, the rotor wash at taxiing power will create a restriction to visibility from blowing snow. If this should occur, taxi the helicopter at a low pitch and higher ground speed, if possible, to get ahead of the blowing snow, or have the helicopter towed to a takeoff position. Ground handling characteristics of the helicopter on loose or packed snow at temperatures below -18°C are good, and wheel braking action is fair to good. However, as temperatures rise toward freezing, snow-covered surfaces become more slippery and increased caution must be exercised.

TAKEOFF.

Select an area devoid of loose or powdery snow to minimize the restriction to visibility from blowing snow, and ascertain that the wheels are not frozen to the snow or ice.

DURING FLIGHT.

During flight, use the cabin heater, engine inlet anti-icing, and windshield anti-ice protective systems, as required. After takeoff from water, wet snow, or slush covered field, operate the landing gear through several complete cycles to preclude their freezing in the retracted position. Slower operation of the landing gear can be expected in cold weather due to stiffening of all lubricants.

WARNING

In the event inadvertent icing is encountered without a foreign object deflector installed, a change of altitude should be made to avoid icing conditions. Without a deflector, the accumulated ice forward of the engine can be dislodged and ingested causing a single or dual engine failure. The ice particles can cause sufficient amount of damage to the engines that a restart would be impossible.

DESCENT.

Accomplish normal descent as outlined in Section II.

LANDING.

If possible, select an area clear of loose or powdery snow so that visibility will not be restricted by blowing snow. Loose powdery snow and crusts (surface and hidden) should be anticipated on all landings on snow. Snow depth is less in clear areas where there is little or no drift effect. The snow coverage in clear areas normally forms gentle swells similar to the swells present in a large body of water. The crest of these swells are usually crusted and are suitable for landings. Generally, the heaviest crust will be present on the upwind side of the crest. Deep snow is prevalent in valleys and to the lee (due to the prevailing winds) of wooded areas and ridges. These are suitable for landings. The best procedures to minimize blowing snow is a running landing. If terrain does not permit a running landing, an approach to a touchdown should be made. Limited visibility will result if hovering is attempted before touchdown. If possible, landings should always be made where visual ground reference can be maintained. After contacting the surface, maintain maximum rpm, while slowly reducing collective pitch to a minimum until the wheels come to rest on a level plane or the bottom of the fuselage comes to rest on the surface. This will prevent any serious consequences if one wheel should hang up or break through a crust of snow (in which case another landing site will have to be selected). Providing there are no obstructions, the tail rotor will be clear when the fuselage rests on a surface or a nose low attitude is maintained. Except in an emergency, never reduce rpm until it is positively determined that the helicopter will not settle. Competent personnel should physically check the snow depth and hardness and, if possible, evaluate the surface before reducing rpm. Make smooth power changes when the fuselage is resting on the surface.

WARNING

Main rotor and tail rotor blade ground clearances are reduced with the helicopter resting on the fuselage. Therefore, personnel entering or leaving the helicopter should exercise extreme caution to preclude being struck by the blades.

CAUTION

If the smoke grenade, or any other object that may be used as a reference should become completely obscured during the approach and/or landing, accomplish a go-around.

STOPPING OF ENGINES.

Make a normal engine shutdown as outlined in Section II. As soon as the helicopter is parked, check the wheels and release the brakes. If parking brakes are left on in slush and snow, the brakes may freeze. At extremely low temperatures, the collective pitch lever friction lock should be left in the OFF position during shutdown. After shutdown, when the helicopter becomes cold soaked, the friction lock nut will contract on the collective pitch lever causing it to bind if left in the ON position. If the friction lock was left ON during extremely low temperatures, the pilot's compartment will have to be heated sufficiently to allow the friction lock nut to expand and again be moveable.

BEFORE LEAVING THE HELICOPTER.

When possible, leave helicopter parked with full fuel tanks. Every effort should be made during servicing to prevent moisture from entering the fuel system. Condensation should be drained from the fuel and oil sumps and drains, and all ice removed from vents, drains, and breathers. Close the door, hatch, and maintenance platform. Clean landing gear oleo struts of dirt, snow, and ice, with a clean cloth soaked in hydraulic fluid. Check that protective covers have been installed. (Engine exhaust and air-inlet protective covers should not be installed until after engine cools down.)

HOT WEATHER PROCEDURES.

Hot weather operation, as distinguished from desert operation, generally means operation in a hot and humid atmosphere. High humidity usually results in the condensation of moisture throughout the helicopter, which causes malfunctioning of electrical equipment, fogging of instruments, rusting of steel parts, and the growth of fungi in vital areas of the helicopter. Further results may be the pollution of lubricants and fluids and deterioration of nonmetallic materials. Normal procedures, outlined in Section II, will be followed for all phases of operation with emphasis placed on the data contained herein. More power will be required to hover during hot weather than on a standard day. Hovering ceilings will be lower for the same gross weight and power settings on a hot day. The flight should be thoroughly planned to compensate for existing conditions by using the charts in the Appendixes. Check for the presence of corrosion or fungus at joints, hinge points, and similar locations. Any fungus or corrosion found must be removed. If instruments, equipment, and controls are moisture-coated, wipe them dry with a clean, soft cloth.

NOTE

As fuel density decreases with a rise in ambient temperature, total usable fuel quantities will be reduced, thus resulting in a decrease in normal operating range.

BEFORE LEAVING THE HELICOPTER.

When the helicopter is parked, doors, windows, and ramp should be left open if weather permits. The pilot's window should remain closed to prevent unexpected rain showers from pooling water on the AFCS channel monitor panel which could possibly create short circuits in the AFCS. The copilot's window should remain closed to protect the HF radio from rain.

DESERT PROCEDURES.

Desert operation generally means operation in a very hot, dry, dusty, often windy atmosphere. Under such conditions, sand and dust will often be found in vital areas of the helicopter. Severe damage to the affected parts may be caused by sand and dust. The helicopter should be towed into takeoff position, which if at all possible, should be on a hard clear surface, free from sand and dust.

PREPARATION FOR FLIGHT.

Plan the flight thoroughly to compensate for existing conditions by using the charts in the Appendix. Check for the presence of sand and dust in control hinges and actuating linkages, and inspect the tires for proper inflation. High temperatures may cause overinflation, the oleo struts should be checked for sand and dust, especially in the area next to the cylinder seal, and any accumulation removed with a clean, dry cloth. Inspect for, and have removed, any sand or dust deposits on instrument panel and switches, and on and around flight and engine controls.

ENGINE STARTING, WARMUP, AND GROUND TESTS.

If possible, engine starting and ground operation should be accomplished from a hard clean surface. Accomplish the normal engine start, warmup, and ground tests as outlined in Section II, but limit ground operation to a minimum as the downwash from the main rotor may stir up clouds of sand. Every effort should be made to minimize the sand from being blown up around the main rotor and engines.

TAXIING INSTRUCTIONS.

When it is absolutely necessary to taxi in sand and dust, get the helicopter airborne as quickly as possible in order to minimize sand and dust intake by the engines.

TAKEOFF.

Execute normal takeoff and climb as outlined in Section II. If the rotor should stir up sand and dust, takeoff, but do not hover, and climb out as rapidly as possible.

DURING FLIGHT AND DESCENT.

Avoid flying through sand or dust storms, when possible. Excessive dust and grit in the air will cause considerable damage to internal engine parts.

LANDING.

The best procedures to minimize blowing sand and dust is a running landing. If the terrain does not permit running landing, an approach to touchdown should be made.

CAUTION

If operation in sand cannot be avoided, landings should be made using an approach angle that is greater than the angle used for normal approaches. The approach angle should be compatible with available power. Touchdown roll should be kept to a minimum to preclude the possibility of overloading the landing gear. Maximum performance takeoffs should be used. All doors and windows should be kept closed during landings and takeoffs to help prevent sand from entering the cockpit and cargo area. These procedures will lessen sand clouds and ensure greater visibility. Hovering and prolonged operation in sand is not recommended because unpredictable foreign object damage can result.

STOPPING ENGINES.

The engine should be shut down as soon as practical, after landing, to minimize the ingestion of sand and dust.

BEFORE LEAVING HELICOPTER.

Accomplish the normal procedures as outlined in Section II. Install all protective covers and shields and leave windows and doors open to ventilate the helicopter, except when sand and dust are blowing.